PRELIMINARY GEOTECHNICAL REPORT FIELD SECTION 21

21.1 SCOPE. To establish guidelines for conducting, sampling for, and reporting of preliminary geotechnical reports.

21.2 APPARATUS. A list of equipment requirements is contained in AASHTO T86.

21.3 PROCEDURE. The preliminary geotechnical report originates in, and is the responsibility of, the District. Cut classification, preliminary sounding for structures, the locating of critical foundation areas, and fertility sampling are considered part of the preliminary geotechnical report. The preliminary geotechnical report shall be conducted essentially in accordance with AASHTO T86, "Investigating and Sampling Soils and Rock for Engineering Purposes", and the Geology and Soils Manual, 1962 Edition, Chapter III, Missouri State Highway Commission. These references are guides and are not intended to preclude the use of ingenuity and judgment.

21.3.1 Description. Description of soils shall be in accordance with the visual-manual procedures of ASTM D2488. Description of rock materials shall be in accordance with ASTM C294. The Stratigraphic Succession in Missouri and subsequent publications of the Missouri DNR, Division of Geology and Land Survey shall be used as guides to stratigraphic identification. Rock quality designation (RQD) shall be used wherever applicable in logging rock cores.

21.3.2 Sampling. Samples shall be obtained in accordance with methods listed in AASHTO T86. In addition, the Giddings slotted-tube sampler has proven particularly suitable for many preliminary geotechnical report sampling applications.

21.3.2.1 Soil Classification Samples. Samples shall be obtained, for classification by ASTM D 2487 and AASHTO M145 (except that group index will be calculated by procedures of M 145-49) and for determination of natural moisture content, at intervals of 5 feet [1.5 meters] or less in at least one hole from each cut with a significant amount of soil. Except in extraordinary circumstances, samples should be obtained from multiple (3 or more) representative locations and from each cut where depth of soil is 10 feet [3 meters] or more. Borrow areas other than roadway cuts shall be similarly sampled in detail to define the range of properties of the material to be borrowed. Classification samples shall be packaged in plastic bags, tied, and double packaged in heavy Kraft paper bags. Bags shall be securely packaged in heavy cardboard boxes for shipment. Alternately, samples may be packaged and shipped in small canvas sacks with plastic liners. Moisture samples shall be sealed in air tight containers for moisture determination in the district Operations Laboratory.

*Note: It is intended that sufficient samples shall be obtained, without sampling bias, such that test results will be reasonably indicative of the dispersion of properties of the soils to be encountered in grading. The number of locations sampled should depend upon the size of the job but three is considered the minimum acceptable for a small job. The number of samples at each location in turn should depend upon stratification and upon the depth of material to be excavated and/or left in place as subgrade.

21.3.2.2 Stabilization Samples. Samples shall be submitted for evaluation of lime or portland cement stabilization, if applicable, in accordance with Field Sec 307 and 308, respectively, of this Manual.

21.3.2.3 Fertility Samples. Composite samples of material, from each soil that will comprise the finished surface layer of the right-of-way to be seeded, shall be sent to the Laboratory for fertility tests. The number of samples will depend upon the judgment of the geologist. Samples should weigh about 1 lb (0.5 kg) and be shipped in small canvas sacks with plastic liners. The following information shall accompany the sample

(a) Soil type - by horizon(s) if applicable.

(b) Type of project: rural, urban, or the approximate percentage of each when a combination.

(c) Project location and length.

(d) Station limits and approximate percentage of total area represented by the sample.

(e) Whether sampling for the project is complete.

21.3.3 Sample Identification. Sample Identification record shall be entered in SiteManager and shall accompany all samples shipped to the Laboratory.

21.3.4 Quarantine Areas. In quarantine areas, all sampling procedures shall be in accordance with Field Sec 28 of this Manual.

21.3.5 Critical Foundation Areas. Requests for investigation of any critical foundation areas located during the preliminary geotechnical report shall be made in accordance with Field Sec 26 of this Manual.

21.4 REPORT.

21.4.1 Preliminary Geotechnical Report. The report shall be in letter form as shown in Exhibit 21-A of this Section. Since preliminary geotechnical reports differ in scope and complexity, a rigid format for the letter portion is not prescribed. This report should be clear, concise, and in outline form if long or detailed. The report shall contain the following information, as applicable:

(a) Brief description of the project including location and station limits.

(b) Identification and brief description of soil types and geologic formations to be encountered. Soil type descriptions shall include a note on the geologic origin, i.e., whether glacial, alluvial, residual, or loessial.

(c) Recommendations on handling and classification of excavation, undergrading, and exceptions or additions to standard specifications for moisture control.

(d) Definition, limits, and recommended disposition of unsuitable materials.

(e) Contractor furnished borrow. If the contractor is to furnish borrow, specify those permissible soil types which will provide a suitable subgrade and which are both readily available and compatible with slope recommendations. Avoid specifying a soil type which may have only one practical source (and owner). Sample and report one or more possible borrow sites for each acceptable soil type where the owner expresses an interest in furnishing material. (This does not require a commitment on the part of the owner or the department and the contractor is free to use any other source provided defined criteria are met.)

(f) Minimum slopes necessary for long term stability of cuts and fills including bridge spill slopes. Attached Exhibit 21-E shall be used as a guide in preparing recommendations. Slopes should be no steeper than those shown in Exhibit 21-E and justification should be furnished for flatter or steeper slope recommendations. (Flattening or steepening of slopes for reasons unrelated to geotechnical considerations is not the responsibility of the geologist.) Placement of select, not necessarily granular, materials may be practical at bridge ends, particularly at grade crossings, to permit shortening of structures by steepening of spill slopes (in accordance with criteria of Exhibit 21-E. This is normally only practical with assured sources of select borrow which are readily distinguishable from less desirable materials.

(g) Notation of the absence or presence of possible critical foundation areas and reference to special investigations in progress or completed by Materials Engineering.

(h) Recommendations for special drainage features or erosion control practices. Water table observations shall be made and reported for soil cuts whenever there is evidence that saturated conditions may exist. Recommendations shall be included in the report for drainage and/or stabilization of slopes and subgrade.

In instances of widespread or non-localized seepage along areas of side hill fill, selective placement of blankets of available pervious material (normally rock from Class C excavation) should be considered to intercept and daylight the seepage to the outside toe of slope. Well-defined, localized seeps and spring flows, however, may be more economically handled with pipe-aggregate underdrains, particularly where project sources of rock or other pervious materials are limited or non-existent. See also paragraph (i) concerning placement of select granular materials for pavement drainage purposes.

(i) All new pavement is to be constructed on two feet of select rock fill when that material is available in suitable quantities on the project site. This includes Light, Medium, and Heavy Duty pavements of either rigid or flexible design. The preliminary geotechnical report should include a statement concerning whether the quantity of select granular fill available on the job site is adequate, of appropriate quality, and located such that it could reasonably be placed as the top two feet (600 mm) of subgrade material. When the quantity of rock on a job is less than is necessary, but would be a significant portion of that needed, a general estimate of that proportion should also be given in the preliminary geotechnical report. Rock fill from sources other than the roadway balance should also be considered if within reasonable proximity to the job.

Note: This information is important in the early stages of project development because the subgrade material to be used will effect the type of pavement selected, the thickness of a flexible pavement, the type of drainage required, and final elevations.

(j) Location and recommended handling of sinkholes, caverns, mines, etc.

(k) A condition survey of the existing pavement when applicable. (Note: A condition survey need not be considered or handled as a preliminary geotechnical report if done for routine resurfacing only. If a resurfacing project includes widening equivalent to at least one lane of pavement the condition survey should be handled as a preliminary geotechnical report including multiple subgrade samples.)

(l) Any other information deemed necessary.

21.4.1.1 Summary for Preliminary Geotechnical Report. Form M-41, Exhibit 21-B of this Section, is to be prepared and attached to the preliminary geotechnical report for each soil type (normally a pedologic series) encountered and is to contain general descriptions and typical or average test values for the various horizons. Discretion may be exercised as to which horizons justify inclusion of test data. Descriptive and interpretive comments, including the geologic origin of soils, shall be placed in the remarks section (recommendations are to be placed only in the text of the letter). Class A materials other than soils may also be summarized on Form M-41. The soil shrinkage factor to be reported on this sheet is the ratio of maximum dry density, determined from the moisture-density relations test, to the natural dry density. This will be only one consideration for designers in estimating a balance shrinkage factor for the project.

Note: Form M-41 is not to be used as a substitute for Form M-42, Subsurface Logs for Preliminary Geotechnical Report. Form M-41 is a summary form and need only include that test data considered typical or average.

21.4.1.2 Subsurface Logs for Preliminary Geotechnical Report. Form M-42, Exhibit 21-C of this Section, shall be used for all auger and core drill logs, etc., and shall be attached to the preliminary geotechnical report. All detailed sample test data shall be reported on this form in table form beneath the appropriate boring log.

(This will duplicate some data selected for use in the summary sheets. Core logs shall include, in table form, the driller's record of runs and recovery and, when appropriate, the rock quality designation (RQD) in percent.

21.4.1.3 Copies of the preliminary geotechnical report are to be distributed by the District as follows:

Title	Copies
State Materials Engineer	Original & 3
District Design Engineer	1
District Operations Engineer	2
File (s)	

21.4.1.4 Copies of the preliminary geotechnicalreport will be distributed by the Materials Engineering as follows:

Title	Copies
State Design Engineer	1
State Bridge Engineer	1

21.4.2 Preliminary Sounding for Structures. This report consists of a completed Form T-738 as shown in Exhibit 21-D of this Section. Logs of borings performed for the preliminary bridge report should also be reported in the preliminary geotechnical report on Form M42 and are to be repeated on Form T-738 along with the other requested information on that form. Form T-738 has a different distribution than the preliminary geotechnical report and is to be reported separately. No cover letter is required. Copies of the completed form are to be distributed as follows:

Title	Copies
State Materials Engineer	Original & 1
State Bridge Engineer	1
File (s)	

21.4.3 Fertility Sample. No District report is required. Results of the fertility tests will be distributed by the Laboratory in accordance with Laboratory Sec 21 of this Manual.

Inter-Office Correspondence

MISSOURI DEPARTMENT OF TRANSPORTATION

DATE: March 8, 1993

TO: _____

FROM: _____

SUBJECT: Materials
Preliminary Geotechnical Report
Route 3, Job No. J3P0212
Shelton County

The preliminary geotechnical report for the above job has been completed. This 9.8 km length of road extends from the city limits of Durango, Station 0+000, east to the Shelton-Smith county line, Station 9+753. The proposed improvement consists of one 7.3 m roadway of high type pavement with 2.4 m stabilized shoulders and structures at Crooked Creek, Saline Creek and Gordon Road.

This preliminary geotechnical report was prepared in accordance with the strip map furnished September 1, 1992 and the revised alignment furnished November 9, 1992.

Logs of subsurface information are attached. Also attached are preliminary geotechnical report summary sheets with descriptions and typical properties of the varioussoils and horizons encountered.

Soil Types and Geologic Formations:

Soils to be encountered include the Putnam series, underlying glacial till and the Wabash series. The Putnam soil series is a mixed loessial and glacial soil overlying the glacial tills. The thin A horizons are very silty (ML or ML-CL). The B and C horizons are heavy clays (CH) which display high volume ch change characteristics with changes in moisture content.

The glacial till underlying the Putnam will be the predominant soil in grading for this project. It is composed of moderately high PI clays (mostly CH) with minor amounts of admixed sand or gravel. Occasional thin sand lenses are encountered.

The Wabash alluvium will be encountered in the bottoms of Saline Creek and Crooked Creek. This soil will not be used in fills. It is quite variable, ranging from silty sand to silty clay with occasional pockets of heavy organic clays.

EXHIBIT 21-A

Geologic formations to be encountered include the Graydon and Burlington. The "Graydon" is a basal Pennsylvania conglomerate, composed predominantly in this area of chert boulders in a claystone matrix. It rests unconformably on an irregular erosional surface of the Burlington formation. The Burlington is typical of the formation, a medium to thick bedded, hard and cherty limestone.

Grading Recommendations:

Standard moisture controls, now in effect, should be adequate. Field moistures were found to be generally slightly above optimum moistures. The Putnam, while of loessial origin in part, should be excepted from the requirements of Sec 203.3.2.2.

It is recommended that the "Graydon" formation be defined, by special provision, as among those materials to be paid for as Class A excavation. Reference should be made to "any conglomerates, sandstones or claystones of the 'Graydon' or other basal Pennsylvania formations".

Several thousand yards of contractor furnished borrow will be required to complete the job. A possible borrow site was investigated on the Pete Jones property on the south side of the proposed alignment between stations 3+596 and 3+749. This site has Putnam and Glacial till similiar to that to be encountered on the roadway. Suggested wording for a contractor furnished borrow special provision is attached as Appendix A.

Sufficient Burlington limestone should be available to permit construction of a 600 mm layer of rock fill in the top of the subgrade from the east terminus of the job west to at least Crooked Creek. Isolated pockets of sink fill, if encountered, should be excluded from this 600 mm layer but may be used elsewhere in embankments. If it is deemed desirable to extend the 600 mm layer of rock in the top of the subgrade to the west from Crooked Creek, shot rock may be obtained from Smith Quarrry or Hill-Burton Quarry, near Durango.

Slopes:

CH soils from glacial till and the Putnam series will be the worst and the predominant materials in cuts and fills, including bridge approach fills. Accordingly, all Class A cut and fill side slopes should be no steeper than 1:3. Remnants of the "Graydon" formation, to be encountered between Stations 4.358± and 4.419± should be cut on the same slope.

Standard vertical slopes should be adequate in the Burlington where encountered.

Fill spill slopes at Gordon Road, with proposed approach fill heights less than 6 m , could be as steep as 1:2.5 if paved slope protection is used to minimize the effects of cyclic moisture changes. The structures at Crooked Creek and Saline Creek, with greater fill heights, should have spill slopes no steeper than 1:3.

The special foundation study in progress at Saline Creek could influence fill side and spill slope requirements at that location.

Foundations:

Preliminary foundation information for structures at Crooked Creek, Saline Creek, and Gordon Road was submitted on February 10, 1993.

EXHIBIT 21-A (Continued)

Possible foundation problems exist in the Saline Creek bottom between Station 6+461 and 6+644. A special foundation investigation for this area was requested in our letter of February 16, 1993.

Drainage and Erosion Control:

A wet weather spring right of centerline at Station 10+454 will fall under a side hill fill. A pipe-aggregate underdrain is recommended to intercept and daylight flow from this spring.

Fertility samples have been submitted to the Laboratory.

Cut slopes exposing remnants of "Graydon" formation, to be encountered between Stations 4+358± and 4+419± should be undergraded and capped with 450 mm of soil to promote growth of vegetation and minimize erosion.

EXHIBIT 21-A (Continued)

MISSOURI DEPARTMENT TRANSPORTATION

MATERIALS ENGINEERING

Summary for Preliminary Geotechnical Report

Sheet 2 of 3

County Shelton Route 3 Job No. J3P0212

HORIZON	THICK-NESS	CLASSIFICATION ASTM	CLASSIFICATION AASHTO	DESCRIPTION	SHRINK, FACTOR
A[1] & A[2]	457 mm	ML	A-4(8)	Light gray sandy silt	1.25
B	381 mm	CH	A-7-6(20)	Dark brown mottled red clay	1.13
C	1066 mm	CH	A-7-6(20)	Light brown mottled gray clay	1.10

HORIZON	% PASSING 19.0 mm	% PASSING 425 µm	% PASSING 75 µm	M.D. kg/m^3	O.M. %	PI	LL	STATION SAMPLED	LAB NO.**
A[1] & A[2]	100.00	98.00	95.00	1633.00	18.00	6.00	31.00	4+358	92-6013
B	100.00	98.00	98.00	1473.00	25.00	38.00	64.00	4+358	92-6014
C	100.00	99.00	98.00	1553.00	21.00	40.00	63.00	4+358	92-6015

SOIL SERIES
Putnam
found from:

Remarks: Shrinkage factors from Geology & Soils Manual.
This soil is of mixed (glacial and loessial) origin.

Sta. 3+779 to 4+023

4+297 to 4+511

6+217 to 6+461

6+644 to 6+858

* Description & soil properties are represented only as average or typical values

** Test reports are on file with in the District.

EXHIBIT 21-B

FORM M-42

MISSOURI DEPARTMENT OF TRANSPORTATION MATERIALS ENGINEERING
SUBSURFACE LOGS FOR PRELIMINARY GEOTECHNICAL REPORT

Sheet 6 of 10

County Shelton Route 3 Job No. J3P0212

Logged by J.E. Shad Date Work Performed December 1992

LOCATION	LOG OF MATERIALS	CLASSIFIED BY
3+870, C_L	0-0.6 m Light gray clayey silt. 0.6 - 1.8 m Brown clay, mottled gray. 1.8 - 7.2 m Stiff gray glacial clay with some sand and pebbles	75 mm Power Auger
3+901, C_L	0 - 0.5 m Light gray sandy to clayey silt. 0.5 - 1.4 m Brown clay, mottled gray. 1.4 - 8.7 m'Stiff gray glacial clay, with some sand and pebbles.	100 mm Power Auger and 75 mm Gidding Sampler
3+931 C_L	0 -0.3 m Light gray sandy silt. 0.3 -0.9 m Brown clay, mottled gray. 0.9 - 7.1 m Stiff gray glacial clay with some sand and pebbles. 0.9 - 3.1'	75 mm Power Auger
5+364 C_L	0 - 0.5 m Light brown clayey silt. 0.5 - 3.2 m Stiff brown to gray glacial clay with sand and pebbles. 3.2 - 9.4 m Medium bedded, hard gray cherty limestone (Burlington).	Failing 1500 Wash Boring and NX core

Test Data

Depth	PI	LL	Wn. %	ASTM	AASHTO
1.2 m	39.00	62.00	26.40	CH	A-7-6-(20)
2.1 m	41.00	67.00	26.80	CH	A-7-6-(20)
3.3 m	24.00	40.00	18.10	CL	A-6-(12)
4.8 m	37.00	60.00	23.70	CH	A-7-6-(20)

From	To	NX Core, No Recovery	L-92-32 Loss	RQD (%)
3.30	4.80	4.9	0.10	89.00
		5.0		
		5.0		
		4.7		
4.80	6.30	5.00	0.00	95.00
6.30	7.80	5.00	0.00	100.00
7.80	9.40	4.70	0.30	79.00

EXHIBIT 21-C

T-738

MISSOURI DEPARTMENT OF TRANSPORTATION
MATERIALS ENGINEERING
PRELIMINARY BRIDGE INFORMATION

County Shelton Route 3 Job No. J3P0212

Structure Over Crooked Creek Stationing 6+492

Reported By J. E. Shad Equip. Used 100 mm Power Auger Date Dec. 7, 1992

Station 5+760 C_L

Depth	Description of Materials
0 - 1.5 m	Brown sandy silt, soft, wet at 0.9 m
1.5 - 4.1 m	Brown silty clay, stiff.
4.1 - 6.6 m	Dark gray glacial clay with gravel, stiff.
6.6 - 6.8 m	Limestone, hard.

Station _____

Depth	Description of Materials

Geologic formations encountered Burlington

Are pinnacles, crevices or cavities anticipated? Possible

Depth to Water Table 1.5 m± Is scour anticipated? No

Is difficulty anticipated in gaining access to site? Yes, East side of creek in crops.

Foundation Problems, if any: None

Will a special investigation be requested? No

Other comments: If possible, soundings should be delayed until crops are harvested.

Materials Engineering- Original
Bridge - 1 copy
District Copies

EXHIBIT 21 - D

Guide for Slope Recommendations

Geologic Origin	Glacial, Alluvial & Loessial Soild; plus Rock-Free Residual Soils Derived from Shales, Claystones, & Siltstones					Soils Residual from rock with admixed Chert or Rock Fragments[4]	Class C [5]
General Description	Sands [1]		Silts & Loesses [2]	Clays of Low Plasticity	Clays of High Plasticity [3]		
ASTM Classification	SP, SM	SW, SC	ML, ML-CL	CL	CH	CL, CH, GC	
Backslope	1:2.5	1:2	1:2.5 (2)	1:2.5	1:3	1:2	(Standard)
Fill Side Slope	1:2.5	1:2	1:2.5	1:2.5	1:3	1:2	1:2
*H≤ 6m	1:2.5	1:2	1:2	1:2	1:2.5	1:2	1:2
Fill Spill Slope [6] *H > 6m	1:2.5	1:2	1:2.5	1:2/5	1:3	1:2	1:2

*H is elevation differential between toe of spill slope and grade at end of structure.

Note 1. Soil caps to control erosion may be required for sandy soils other than SC.

2. Essentially vertical cut slopes may be used in loess when indicated to be practical by criteria outlined in MCHRP Report 74-1.

3. Especially high PI materials, >50, should be used with caution. Consideration should be given to wasting or to even flatter slopes.

4. Consider flatter slopes where height of fill exceeds 12 meters and percentage of admixed granular material is less than 40%. Refer to MCHRP Report 75-1 for more information.

5. Locally steeper slopes for Class C fills are practical only with special handling in excavation and placement.

6. Steeper slopes for low spill slopes assume some form of slope protection to control erosion and/or cyclic moisture changes.

7. Refer to MCHRP Report 79-1 for recommended handling of gley, Cheltenham claystone and Maquoketa clay shale

This chart is to be used as a guide for selection of slopes. Factors such as foundations, seepage, susceptibility to inundation, etc. may dictate flatter slopes. Soils classified OH, OL & MH by ASTM Classification are rare and, if encountered, may require special design or handling.

It is not intended that a slope should be varied with every horizon or soil type encountered but rather that slopes selected for a project should be determined from an overall evaluation of the predominant soils encountered on the project. In the event of uncertainty, a conservative selection would be prudent. For example, A and B horizons will normally be thin and less plastic as compared to the C. In such cases, the slope selection logically would be based on the C horizon as both the worst and predominant material to be encountered.

Slopes should be varied horizontally within a project only if the alignment traverses two or more distinct soil types and only if it is known where material from any cut in the transition zone will be placed in fill. In the event of uncertainty, the more conservative slope should be extended to the point where there can be no uncertainty. In most cases, a constant slope design would be used throughout a given project.

EXHIBIT 21-E